UNIVERSAL GRAPHICAL USER INTERFACE FOR MULTI VENDOR EDFA OPTICAL MODULES CONTROL

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Abstract: This article describes design and development of a universal software for communication with erbium-dopped fiber amplifiers (EDFA) optical modules using serial line. User-friendly environment created in LabView enables not only setting of EDFA parameters but also reading all necessary EDFA parameters at the same time. Multi vendor interoperability is made possible by the proposed simple implementation of control commands that are stored in a text file.

Keywords: EDFA, GUI, LabVIEW, optical fiber, serial bus

1 INTRODUCTION

Most of today's telecommunication networks use optical fiber as the transfer medium. There are a lot of reasons (price, speed, capacity, etc). For longer distances signal amplification is usually necessary because of signal attenuation during propagation in optical fibers. Optical amplifiers can be divided into power amplifiers (booster), preamplifiers, and in-line amplifiers [1]. Every amplifier allows reading of states (power, temperature, alarms, etc.) and simultaneously adjusting the main parameters.

These amplifiers are mostly controlled by text commands over a serial line. The problem is in high complexity of some programs, such as in case of software presented in [2]. On the other hand there are programs that support only basic settings option [3]. There are also programs, that only monitor the status of optical amplifiers [4] without parameter set options. So the GUI software has to be designed to communicate with the device.

As a design tool for creating graphical user interface LabVIEW was selected [5], which is mostly used for laboratory devices control.

The software created in this way must be able to communicate even with similar devices from different manufacturers. Therefore it is advisable to design the software so that the commands can be modified without changing source code.

Paper is structured as follows. Section I gives a fundamental overview of optical networks with amplifiers. Section II gives basics about optical amplifiers. Section III describes the tested EDFA module. In section IV and section V universal GUI is explained. Finally, section VI concludes the paper.

2 EDFA AMPLIFIER

The main components of EDFA amplifiers are several meters long erbium-doped fibers, pump laser diode, isolators, WDM couplers and electric circuits with processor. The processor controls the parameters of the given amplifier. The basic schema is shown in Figure 1. The radiation of the laser pump that occurs in erbium-doped fiber results in excitation of erbium atoms to higher energy levels.

This fiber retains the energy obtained from the laser pump [1]. Signal parameters, like the phase and the signal shape are not changed during amplification. Therefore, only the signal intensity is only increased. This phenomenon causes signal gain up to 50 dB (C and L band [4]). The disadvantage of this amplification method is that it is a reinforced signal, therefore it also brings its own ASE noise (Amplified Spontaneous Emission) [6].

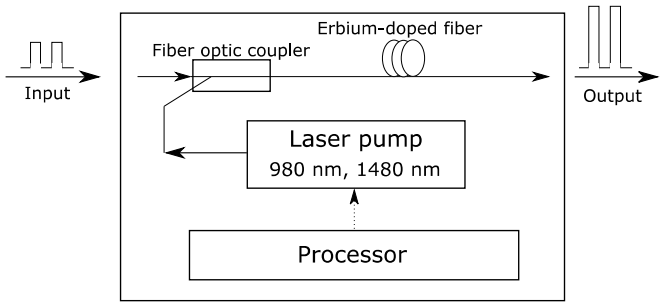

Figure 1: Schema of EDFA amplifier [1].

2.1 GOA Module EDFA

GOA Module (Generic Optical Amplifier) or MSA (Multi-Source Agreement) EDFA is an optical amplifier, suitable for integration in its case. It can be seen in Figure 2. This module is made for signal amplification in C-band (1530–1565 nm) with high optical output power. Communication with this device is realized via the RS-232 serial line. For tests and GUI verification we used two different optical amplifiers from different manufacturers which means that different commands must be used for EDFA control.

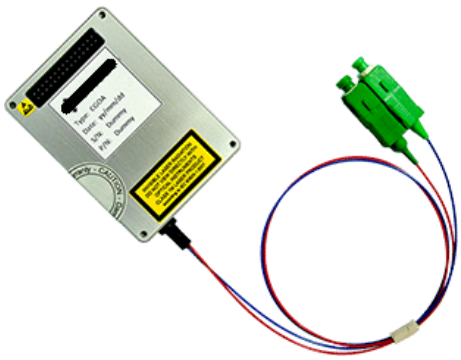

Figure 2: GOA Module EDFA [7].

3 GUI FOR EDFA 1

The program is divided into two parts. The first part waits if any button is pressed for sending data. If nothing is pressed the second part reads and restores GUI values.

All commands for this module are loaded from a prepared text file. Data transmissions to EDFA module is much simpler than data receiving. In the first part, the program checks if the path to the command file specified by the user is correct. If not, the program invokes a dialog box where the user selects the file path. Then the program reads all the commands from the file and stores them in a variable.

For setting parameters the user enters the value he wants to write and presses the button SET. At that moment, the program interrupts the automatic value retrieval function and selects the correct command and sends it over the serial line. EDFA module sends confirmation of successfully received command. The front panel of EDFA 1 GUI is depicted in Figure 3.

The variables to be set are arranged so that there is a selection mode at the top left, while on the right side there are only values for each mode. For current mode, current values for both lasers can be set in the power section. There are two modes. In the *power mode* the values are in dBm, in the *gain mode* the values are in dB. Units of set variables are located next to the boxes with values.

During the operation the amplifier settings are refreshed and always up to date. Because some parameters change only when changed by the user, all values must be loaded during the first cycle of the program. Values that cannot be changed without user activity remain out of date. When sending any changes, EDFA sends back the confirmation. The program waits for this confirmation and adjusts the values at the bottom of the front panel. There are temperatures and current settings of both lasers. The second column contains general EDFA parameters such as internal temperature, operating mode, gain, and output power.

In the right part, there are indicators of alarm errors. Each cycle the program sends a command to get alarm status. The program first resets the values and then turns LEDs into the red when the alarm is triggered. Alarms detection program detect by the keywords listed in the datasheet of this module. As soon as the alarm is canceled, the corresponding LED changes color to green. The program can respond to any command the device knows or can generate it. There are all the instructions in the manual. Some of the datasheet commands do not work. This is, for example, trigger gain mode. It is possible that this datasheet is created for a slightly different firmware version of the amplifier.

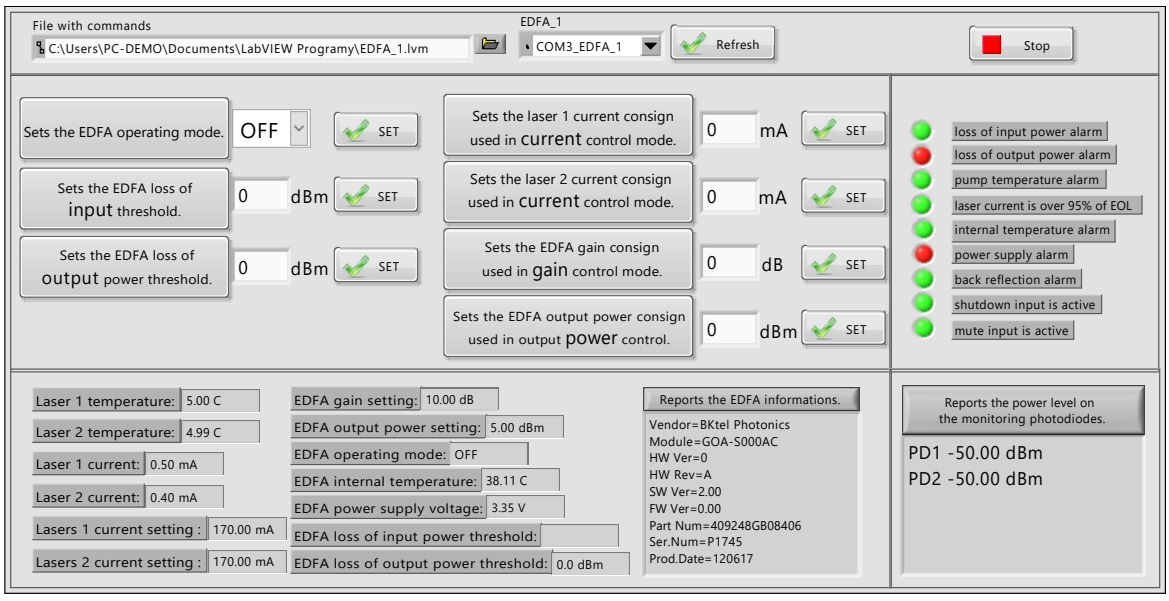

Figure 3: Front panel of GUI for EDFA 1.

4 GUI FOR EDFA 2

The EDFA 2 program is depicted in Figure 4. It is based on the EDFA 1 program. It is also programmed via serial line and using similar commands. However, commands are longer and more detailed. After setting the serial line according to EDFA 2 datasheet, it is the same process as in the

previous program. One part sends the commands and the other refreshes values and listens. It proceeds the same way as the previous program. If a button is pressed, it sends the appropriate command over the serial line. The only difference is in the number of buttons. In this program, the buttons labeled SET are eight. The arrangement is the same as in the previous program. Also, the button is used to enable or disable automatic shutdown. After sending the GUI listens to the confirmation from the amplifier. When data is retrieved, all fields from the bottom are filled only in the first cycle.

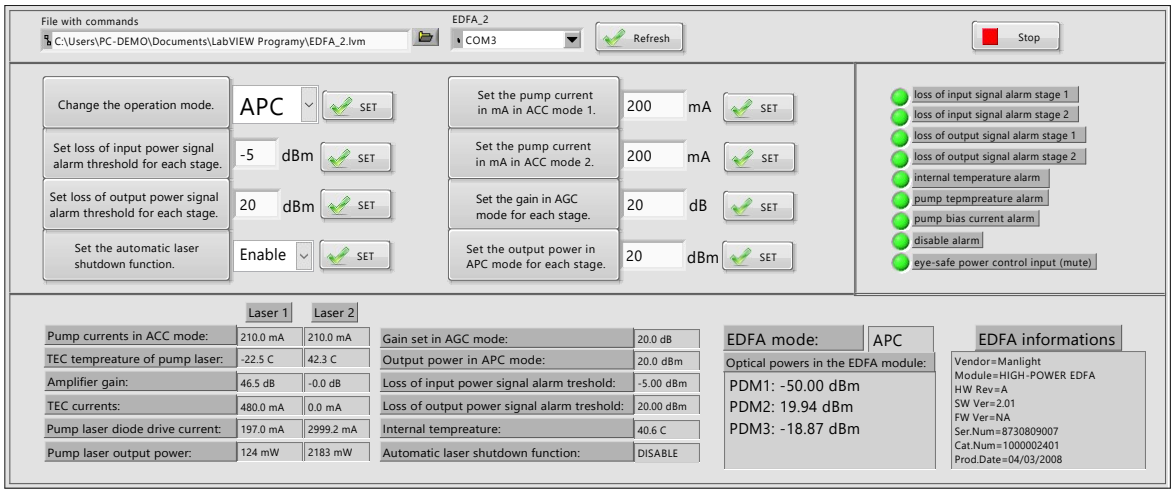

Figure 4: Front panel of GUI for EDFA 2.

Also, only values that are not changed by the user are loaded. The problem with this amplifier is the fact that it does not send back the command value but only the laser value. The command RLT 1 is for laser temperature (the command file is shown in Figure 5). The amplifier's response is LT 1 20C. It can be easily detected. The LT letters are unique. For EDFA 2, the command to detect the temperature is LT 1. However, the answer is LASER 1: 20 C and for each additional command comes the answer in the same format. It is not possible to detect the value of this, therefore the program is extended of the memory of sent commands and assigns values to the command. That is why the program is a little slower because each time you request data it is necessary to wait for a response while the EDFA 1 program is able to collect responses quickly.

```
                                    EDFA_1
Reports the EDFA alarms status. RA
Reports the lasers temperature. RLT X
Reports the lasers current.     RLC X
Reports the EDFA internal temperature.  RIT
Reports the EDFA informations.  RI
Reports the power level on the monitoring photodiodes.  RPM
Reports the EDFA power supply voltage.  RV
Reports the EDFA loss of input power threshold. RLI
Sets the EDFA loss of input threshold.  SLI YY.YY
Reports the EDFA loss of output power threshold.        RLO
Sets the EDFA loss of output power threshold.   SLO YY.YY
Reports the lasers current setting used in current control mode.        RCC X
Sets the lasers current consign used in current control mode.   SCC X YYYY.YY
Reports the EDFA gain setting used in gain control mode.        RGC
Sets the EDFA gain consign used in gain control mode.   SGC YY.YY
Reports the EDFAoutput power setting used in output power control mode. RPC
Sets the EDFA output power consign used in output power control.        SPC
YY.YY
Reports the EDFA operating mode.        RMODE
Sets the EDFA operating mode.   SMODE XX
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Figure 5: Text file with commands for EDFA.

The indicators of the alarm status are placed on the right side so that the programs have a similar form. At the bottom, the values are arranged differently than in the previous program. The left column labeled Laser 1 is for the first laser and Laser 2 for the second. The next column contains the

values that are used for the entire module. In the third column is the value of the set mode and optical power of this module. The last column contains information about the device, such as manufacturer name, module type, version, firmware, software, etc.

5 CONCLUSION

A graphical user interface for two EDFA optical amplifiers in LabVIEW environment was created. These programs were created in LabVIEW. Programs communicate using commands sent over the serial line.

Program functions have been tested and incorporated into the final version of the program. Both programs can work as a single program communicating with both amplifiers. Each program can be used for another EDFA module, thanks to the possibility to modify the individual commands directly in the text file. Both programs load individual module commands.

Compared with other solutions of graphical user interface, this solution offers enhanced functionality. It also loads and displays the current status of the EDFA. The front panel is programmed to be controlled intuitively and the user can modify EDFA settings without knowledge of control commands.

The program communicates with the amplifiers over the serial line. Updating of EDFA settings is very quick. Optimizing communication causes shorten the time, which is necessary to speed up the communication.

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